SPECIFICATION

TITLE

"SYSTEM FOR CALCULATING ANALYTICAL DATA AND MAKING CALCULATION RESULTS AVAILABLE AS AN OUTPUT"

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a system for calculating and providing analytical data as an output, particularly medical analytical data.

Description of the Prior Art

Lay persons, particularly lay persons who are medical patients, require information from experts such as doctors for concrete problems such as health. Such a consultation usually takes place in person; i.e., the person desiring information must visit the expert, for instance the doctor. It is possible to discuss the current problem and the individual situation concretely in the context of such a personal interview. The course of the consultation or the informational interview can be dictated by the participants themselves. Uncertain statements can be followed up and taken into account in the final result, so that it is possible to make and discuss alternative statements. Such a consultation must proceed openly, in the sense that it does not necessarily result in a final decision.

It is not always possible, however, to consult with experts in case of need, and such consultation is relatively costly.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a system of the type initially described which is capable of conveying a specific item of information to the information seeker with respect to a concrete problem, which makes it possible to generate the

given information in the form of analytical data, such as occur on the part of the expert in the context of a personal consultation.

This object is achieved in accordance with the invention in a system having a computer with an evaluation unit for analyzing information that can be entered by the system user and for generating analytical data, and an output medium at the user side, the evaluation unit being configured for interrogating and accepting information entered at the user side, both for allowing information to be entered autonomously by the user based on a number of inquiries which are predefined at the system side, and which are selectable with respect to the response, and which can be omitted via the output medium. The evaluation unit also is configured for controlling an interactive information capture so that specific inquiries can be formulated and made available as an output depending on the previous information. The evaluation unit is configured for processing information that is random in content and for evaluating the analytical data with a continuous value measure, so that it is possible for the user to retrieve and output, at any time, the analytical data that can be generated on the basis of previous information.

The inventive system enables the system user to obtain the necessary information by exchanging information with the evaluation unit, or with the system itself. To collect the information required for the generation of the analytical data, the evaluation unit can be operated in various modes of operation. In one mode, questions which are defined at the evaluation unit side are given to the user, who can answer them with "yes" or "no," for example, or, in the case of a system configured for medical problems, by indicating body temperature or the like. In this way, information can be collected which the user himself can recognize and acquire. Compared to a personal

consultation, information thus can be captured which the expert collects, for instance the doctor may ask the question "Which symptoms of disease do you have?" to which the patient responds, "skin rash".

In addition, the inventive evaluation system is also capable of formulating questions autonomously, based on the existing information, in order to intentionally solicit information it requires for purposes of generating the analytical data. To this end, the evaluation unit can be an expert system such as a neural network or a Bayes network, for example, the system being configured for generating and formulating corresponding questions that influence the analytical data in some way. Information thus can be collected which are obtained in personal consultation by means of purposeful questioning by the expert, who takes into account his or her expertise, as well as the information already given. The evaluation unit is thus capable of processing information with an arbitrary content; i.e., not only absolute items of information such as "yes" and "no" are processed, but also it is possible to process uncertain statements of information by the user such as "I don't know" or the like. The system is completely open; there are no limitations of any kind relating to the enterable information content, or the type of enterable information.

Another particular advantage of the inventive system is that the evaluation unit is configured to evaluate the analytical data with a value measure. This value measure can be a measure of possibility, for instance, of the type that indicates the likelihood percentage that given analytical data are correct and enables the user to advantageously detect "the weight" of the outputted analytical output data, in order possibly to be able to reach a further decision based thereon. The user thus receives

a statement of possibility as to whether, and with what probability, one disease or another may be present, as in a personal consultation. A decision, i.e. stipulating a specific alternative which can be the only one, does not occur. The user can stop the analysis mode at any time and receive the result of the analysis ~~ans~~ as an output. That is, the system is flexible to the extent that it does not require a specific amount of information to corresponding inquiries. Rather, the analysis can be brought to an end at any time. In sum, the inventive system enables the user to be able to collect a problem-specific consultation result autonomously, with different information being taken into consideration in the consultation result, and the analytical result is open, as is the case in a personal consultation.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic block diagram of the basic components of an inventive system.

Figure 2 is a schematic block diagram showing the basic components of a second embodiment of the inventive system with a remote computer and remote storage units.

Figure 3 is a schematic block diagram showing a further embodiment of the inventive system with remote storage units.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 depicts the basic components of an inventive system, wherein the local arrangement of the basic components, as described below with reference to Figure 2 and Figure 3, can be arbitrary. That is, they need not be arranged at one and the same location. The system comprises a computing means 1 in the form of a computing or

data processing means. An evaluation unit 2 is provided, by means of which the calculation and output of analytical data occurs. An output medium 3 in the form of a monitor or the like is allocated to a computer 1, at which it is possible to display the analytical data. There is also an input unit 4, which can be an input keyboard, via which the system user can answer the questions displayed to him or her at the output medium 3, though the input can of course also occur via the screen surface of the output medium 3, if this is a touch-screen.

A central element of this system is the evaluation unit 2. This is configured for the interrogation and acceptance of information entered at the user side and can function essentially in two distinct modes of operation. In one mode, predefined inquiries can be visualized to the user via the output medium 3, which he or she can answer with autonomously obtained facts. For example, different possible symptoms which are observable by the user are listed in the form of specific question blocks composed in the fashion of a menu, so that the user can then indicate that symptom which he observes himself , so that approximate primary information is already present. For example, the following choices can be given to the user: "skin rash," "runny nose," "headache," "aching joints," "stomachache." If one of these symptoms is present, which the user can detect himself without further difficulty, then the corresponding field or the corresponding key should be pressed. Depending on this result, another block of predefined questions can then be visualized. If, for example, the key "skin rash" is activated, then "pustules," "flaking" and "reddening" can be given as the next questions.

Additionally, the evaluation unit is fashioned for the autonomous formulation of specific interrogations of the system user, which are determined on the basis of the

basic information which already exists or on the basis of additional entered information. To this end, an expert system is provided at the evaluation unit 2 side, to which a corresponding question selection module is allocated. The configuration in this regard is arbitrary. It is thus possible for problem-specific questions to be posed to the user, which the system can generate autonomously based on the existing information, in order to be able to collect information which is relevant to a well-grounded generation of analytical data. It is possible to select between the modes of operation of the evaluation unit 2 at the user side; i.e., the evaluation unit 2 first operates in the mode with the predefined inquiries, whereby it is capable of generating corresponding analytical data with the thus obtained information. For a more deeply grounded analysis, the user can then switch as needed to the mode of interactive inquiry with autonomous question formulation, whereby the generation of the questions is also based on the already existing information obtained in the other mode of operation.

Furthermore, as described above, the evaluation unit 2 is configured for rating the respective types of analysis with a value measure. This value measure can be calculated continuously between two extreme values. By means of this measure of value or probability, it is indicated to the user with what probability the analytical data for the concrete problem are valid. In the case of a medical problem, it can be indicated to the user in this way what percent chance there is that the disease which has been determined as the result of analysis could be present. Of course, several analytical results in the form of different diseases can be given, to which a separate measures of possibility are respectively given. For example, the following can be indicated to the user:

"Cold: 90%"

"Fever requiring treatment: 10%"

"Rhinitis: 30%",

These analytical data also can apply in an overlapping manner. The determination of the value measure can occur using fuzzy logic. Alternatively, the evaluation unit 2 can be configured for the calculation of the value or possibility measure based on a calculable probability or a probability interval. A probability value for the correctness of the analytical result or an interval, for instance 45-55% probability of presence, is calculated. For the probability calculation, the evaluation unit 2 is appropriately a causal network.

As for the formulation of the interrogation, an expert system and an allocated question generating module can be provided for this purpose, as described. The formulation of the interrogation can occur based on an analytical calculation of the potential informational gain of the respective optionally formulatable inquiry. It is calculated analytically how the analytical data change given the posing of the optionally formulated inquiry, assuming one or more possible user responses. If the potential informational gain is great (that is, the analytical result that can be generated based on the information existing at the moment changes significantly in consideration of the possible user response), then the potential question is a relevant inquiry which should be made. If the analytical result does not change or does so only slightly, the possible question is of secondary importance.

The predefined inquiries can be presented as an output in hierarchically structured form and can be selectable and answerable incrementally at the user side,

whereby they can be displayed, as described, in thematically ordered blocks, in the fashion of a question menu. The user thus has the option to be able to restrict the questions to a specific question.

The evaluation unit 2 also can be configured for the calculation and output of a weight designation with respect to the significance of the displayed inquiries. This weight designation indicates to the user how important the continuation of the data pickup is, in order to arrive at an authoritative analytical result. For example, the indications "high," "average," and "low" can be shown as an output according to inquiry. If the respective inquiry is characterized as a "high", then it can be recognized by the user that this is an important question which he or she should answer to the best of his or her knowledge, since this information enters into the analysis heavily. Very relevant inquiries are thus designated "high", while those whose answers do not affect the analytical result very much are designated "low". This assigning of potential significance designations should occur particularly given questions which are formulated by the evaluation unit 2 itself, since these are problem-specific questions which are formulated using the expert system and so using expert knowledge, which questions are directed to a specific problem in a concrete manner. The calculation of the weight designation can occur based on an analysis of the weighted reduction of the entropy in the evaluation unit 2 under the assumption of different items of response information that may be given in response to the respective inquiry. It is analyzed what an assumed response contributes in terms of clarification in the evaluation unit 2. This is structured such that, for each possible disease, a variety of symptoms are ranked and linked, and for instance each disease-symptom link is linked to a specific percentage of probability.

It is now tested how the multitude of the original links with respect to one or more concrete diseases can be reduced, assuming a specific item of response information; i.e., how the entropy of the links decreases given a significant , facilitative item of information that continues or remains constant, or increases given an item of information that is insignificant or disadvantageous for the analysis. The weighted reduction is thus analyzed; i.e., it is tested whether it is more advantageous to pose a question which is difficult to answer and has a high informational profit or one which is easy to answer and has a low informational profit. A specific algorithm is provided for the calculation of the weight designation.

As shown in Figure 1, a storage unit 5 is provided. Only a single storage unit 5 is depicted in Figure 1, though of course several can be provided. In this storage unit 5, user-specific information such as the age of the user, his disease history or the like can be filed. The evaluation unit 2 can automatically access this storage unit 5 and the information filed therein, or at least a part of this information. Alternatively or at the same time, this user-specific information can be at least partially released for acquisition only by the user, in order to avoid a random data access. Various password or security measures are available for this purpose.

Specific informational data for the analytical data also can be stored in the storage unit 5 or in another storage means (not illustrated), so that the data can be acquired and emitted as an output selectively. The data can be detailed explanations of a specific disease which is indicated as analytical data, it being possible for the user to have the data displayed as needed, if the user is interested in a more detailed description of the disease and possible causes, side effects and treatment options. The

data forms an information database which can be accessed in case of need. An additional storage unit 5 can be further provided (it is also possible to utilize the storage means depicted in Figure 1) in which the entered information can be filed and stored, so that the user can access it given a new inquiry without the information having to be entered again, which may be the case if the user notices the first signs of a disease and has primary analytical data calculated, and the user then has additional analysis performed at a later time, when the symptoms are manifested more clearly.

Besides this additional information, the user can request that the analytical data or at least a part of the information entered at the user side, on the basis of which the value measure was calculated, be shown as an output so that the user can see which of the given items of information were important and relevant to the analysis. So that it is not necessary to display all of the entered information that was employed in the calculation of the value measure, the evaluation unit 2 can be configured to select the output information by calculating a change of the value measure which would arise if a particular item of information were missing. It is thus analytically determined how the measures of value or possibility would be reduced from the present state, assuming the omission of an item of information. If a significant reduction occurs, then this is an important item of information, which should be displayed.

As described above, it is possible for the user to interrupt the operation at any time and have the analytical result displayed. To prevent a specific result from being generated on the basis of erroneous or clearly insufficient information, leading to misconception or incorrect action on the part of the user, the evaluation unit 2 can be configured for self-analysis such that, given a termination of the inquiry prompted at the

user side, it is possible to check for the omission of one or more relevant items of information for the calculation of the analytical data and to allow the calculation result to be shown as an output, given the retrieval of one or more corresponding inquiries, only if warranted. The evaluation unit 2 thus itself checks whether it is capable of a sufficiently well-grounded generation of the analytical data on the basis of the existing information. If not, a preliminary calculation result can be displayed to the user, with simultaneous output of the relevant inquiry or inquiries needed to supply the omitted information, so that the user can answer these inquiries. When these inquiries are answered, the actual calculated, well-grounded analytical data can be made available as an output.

Figure 2 depicts another embodiment of an inventive system. A computer 1 with an evaluation unit 2 is provided in this embodiment as well. This computer 1 is arranged externally to the output medium 3 provided at the user side, in the fashion of a central server. The communication occurs via a communication channel 6, which can be a communication line or a wireless communication connection. An additional computer 7 with an allocated input unit 4 is provided at the user side.

Various storage units 5 are also allocated to the computer 1, which can be arranged externally to the computer 1 and communicate therewith via communication channels 8. These storage units 5 need not be arranged in the immediate environment of the computer, rather, they can be external databases fashioned in the manner of a central server, which the computer 1 can access as needed. One such storage unit 5 can be arranged at the office of a doctor who treats the system user, who is a patient of the doctor, for example. In this storage unit 5 provided at the doctor's office, a variety

of user-specific data are already filed, which can be partially accessed and read out by the computer 1. According to Figure 2, an additional storage unit 5 is also provided at the user side and communicates with the computer 7. Again, it is possible for user-specific data to be filed in this storage unit 5 which, like the previously described data, can either be read out by the computer 1 automatically, or can be released by the user, possibly upon request.

Figure 2 also illustrates the capability for additional system subscribers to be linked to the system, which subscribers can also access the computer 1, via corresponding communication channels 6'.

Figure 3 depicts another embodiment of the inventive system. In this embodiment, both the computer 1 with the evaluation unit 2 and the output medium 3 are provided at the user side; only the storage unit 5 is arranged externally. This can be accessed via a communication channel of any type. Again, more than one storage unit 5 can be provided.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.